

Impact of Blended Learning Approach on Students' Achievement in Quadratic and Simultaneous Equations

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ABSTRACT

This paper examined the effect of blended learning (BL) on students' achievement in Quadratic and Simultaneous equations in Ogun State, Southwest Nigeria. Blended learning is a learning strategy that supplements traditional face-to-face instruction congruent to the traditional lecture method (TLM) with computer-based learning, to which students subscribe. A control group and a quasi-experimental design were adopted for this study. Purposive sampling techniques were applied to select a sample of 320 students drawn from two secondary schools in which intact classes were used. The Quadratic and Simultaneous Equations Achievement Test (QSEAT) was developed with a reliability coefficient value of 0.82, and used as the research instrument. An analysis of covariance (ANCOVA) was used to test the hypotheses. All the hypotheses were tested at the 0.05 level of significance. Results showed that there was a statistically significant main effect of treatment on students' achievement in Quadratic and Simultaneous equations. There was a statistically significant effect of blended learning (BL) on students' achievement in Quadratic and Simultaneous equations. There was a statistically significant interaction effect of treatment control and experimental BL on students' achievement in Quadratic and Simultaneous equations. The findings of the study revealed that the student's achievement in Quadratic and Simultaneous equations was enhanced more when BL strategies were used than when TLM was used. Based on the findings of this study, it was therefore recommended that efforts be made to integrate the philosophy of BL into the preservice teachers' curriculum at the teacher preparation institutions in Nigeria.

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KEYWORDS: *Blended Learning; Traditional Lecture Method; Quadratic and Simultaneous Equations; Achievement Test*

1. INTRODUCTION

Blended Learning Instructional strategy can be defined as an instructional strategy that combines online digital media with conventional teaching methods in class room delivery. The term blended learning instructional strategy is used interchangeably in research literature as “personalized learning”, “differentiated instruction”, “hybrid learning”, “technology-mediated instruction”, “web-enhanced instruction” and “mixed-mode instruction”. The concepts behind blended learning were first developed in the 1960s, the formal terminology to describe it did not take its current form until the late 1990s. Then in 2006, the term became more concrete with the publication of the first Handbook of Blended Learning by Bonk and Graham.

Blended learning combines multiple delivery media that are designed to complement each other and

promote learning and application-learner behavior. Bonk & Graham (2006) as cited in Niu, Ding, and Liu (2020) defined Blended learning as learning systems that combine face-to-face instruction with computer mediated instruction. Currently, the use of the term blended learning mostly involves combining Internet and digital media with established classroom forms that require the physical co-presence of teacher and students (Liu and Chao, 2017). Blended learning, also called hybrid learning is simply defined as a combination of e-learning and the traditional face-to-face (f2f) learning or instructor-led training (ILT), and when necessary coaching, assignments and projects provided as a support and reinforcement tool (Chen, Liu and Lin, 2018). According to Garrison and Vaughan (2008), Blended learning is defined as the thoughtful fusion of face-to-face and online learning

experiences. Therefore, the basic principle is that face-to-face oral communication and online written communication are optimally integrated such that the strengths of each are blended into a unique learning experience congruent with the context and intended educational purpose.

One vital component in teacher-student interaction is instructional strategy and that mathematics teachers feel more comfortable in using the traditional method in teaching mathematics simply because it is more amenable to teaching large class sizes (Dikli and Kocoglu, 2018). Recent reforms proposed by National Council of Teachers of Mathematics (NCTM) standard emphasized the use of technology in teaching and learning of mathematics because technology is changing the world and daily life, yet the teaching of mathematics remained relatively unchanged and still relied on traditional lecture method (TLM) (Abakpa & Iji, 2011). The objective of mathematics education in the global scene is to meet the critical needs of society. Thus, there is a need for teaching and learning strategies that accommodate new technology (Vasileva-Stojanovska, 2015) within the context of active learning. Two of such learning strategies are Problem Based Learning (PBL) and Blended Learning (BL). Therefore, the research paper focused on the effect of Blended Learning on students' achievement in Mathematics.

Teachers who have used a blended learning method in the classroom have seen an increase in student achievement. Classrooms that have incorporated a flipped model in a blended learning environment have seen an increase in student achievement. The educational system has also benefited from the advantages brought by the Internet. The Internet, which offers learners access to information and the opportunity of written, audio and video communication, has entered into a very rapid development process all over the world. This has caused Internet-based education to expand rapidly.

One way to use technology in a blended learning model is the *flipped classroom* approach. The flipped classroom takes the lecture part of the instruction and places it in videos or podcasts for students to watch at night as their homework (Martyn, 2003). Class time is then used for extra guidance and work time on the assignments. There are many advantages to this model of learning; however, Brunsell and Horejsi (2016) noted that "showing video lectures alone is not flipping your classroom - you must add active learning experiences". One such advantage to the flipped classroom is time. Watching the videos at night frees up valuable classroom time for teachers to offer extra guidance to those students who are

struggling and provide more challenging activities for those who find it easy, as well as providing great opportunities for one-on-one mentoring or collaborating (Morgan, 2014; Roehl, Reddy, & Shannon, 2013).

In the meantime, several studies focused on the perceptions and experiences of blended learning among students and teachers. ElSayary (2021) measured seventh-grade students' perceptions of their learning experience in the mobile blended learning environment. Davies (2003) focused on the technology-supported Flipped Classroom Approach (FCA) in mathematics education and how this teaching and learning can be implemented in secondary schools.

Blended learning is a student-centered learning method (Fatade, 2012) that combines traditional face-to-face classrooms (synchronous learning activities) with e-learning activities (asynchronous learning activities) (Thorne, 2003). Young (2002) emphasized the role of the e-learning factor, according to Willet (2002). According to Collis (2013) and Lazar et al. (2020), the ratio between face-to-face and online learning in blended learning varies, but the online learning factor should be between 33% and 50%, and even as high as 80% (Attard & Holmes, 2020).

According to Attard & Holmes (2020), blended learning results from digital technology and digital educational tools. Online tools such as apps, books, and computers can be used as lesson plans, lectures, textbooks, assignments, software, quizzes, tests, resources, audio and video, digital, and social networking platforms such as Twitter, YouTube, and Facebook (ElSayary, 2021). Meanwhile, ElSayary (2011) used the concept of "digital learning tool" to refer to digital sources used in blended learning.

Motivation and interest are key factors that drive the teaching-learning process. In blended learning, e-learning tools are used in lessons, training sessions (Adiguzel et al., 2020), presentations, progress learning, and online discussion groups (Beers, 2015). Several findings report a significant increase of students' motivation and achievement as a result of the blended learning model (Islam et al., 2018; Kholifah et al., 2020; Wong et al., 2020). Osman & Hamzah (2020) also investigated the impacts of implementing blended learning on students' interest and motivation, the findings reveal a higher level of interest and motivation by the students when participating in blended learning classes. This is an indication that the implementation of blended learning has its benefits which include increased student interest, motivation, and academic achievement. Educators should build on these

benefits by finding ways to further improve blended learning. Enhancing this approach could promote more engaged and effective learning.

2. Statement of the Problem

The purpose of this study is to investigate the impact of a blended learning approach on students' achievement in Quadratic and Simultaneous Equations. While traditional lecture-based instruction has been the predominant method used in teaching these mathematical concepts, there is a need to explore alternative approaches that can potentially enhance students' learning outcomes. Blended learning, characterized by the integration of face-to-face instruction and technology-based components, offers a promising avenue for improving students' understanding and performance in Mathematics. However, there is a gap in the existing literature regarding the specific impact of blended learning on students' achievement in Quadratic and Simultaneous Equations.

By investigating these questions, this study aims to contribute to the existing knowledge on the impact of blended learning in Mathematics education, specifically in the context of Quadratic and Simultaneous Equations. The findings of this research will provide valuable insights into the potential benefits and implications of adopting a blended learning approach to enhance students' achievement in these mathematical topics.

3. Purpose of the Study

The study focused on the contribution and impact of the blended learning model to the teaching and learning of Quadratic and Simultaneous Equations and student's achievement in Quadratic and Simultaneous Equations at Senior Secondary School.

4. Research Questions

1. What is the contribution of the Blended Learning Model (BLM) on students' achievement in Quadratic and Simultaneous Equations?
2. What is the impact of BLM on students' motivation towards learning and teaching Quadratic and Simultaneous Equations?

5. Research Hypotheses

H01: There is no significant contribution of Blended Learning Model (BLM) and Students' achievement in Quadratic and Simultaneous Equations at Senior Secondary School.

H02: There is no significant impact of Blended Learning Model and Students' motivation towards learning and teaching of Quadratic and Simultaneous Equations at Senior Secondary School.

6. Review of Related Literature

According to Lazar et al. (2020), blended learning results from digital technology and digital educational tools. Online tools such as apps, books, and computers can be used as lesson plans, lectures, textbooks, assignments, software, quizzes, tests, resources, audio and video, digital, and social networking platforms such as Twitter, YouTube, and Facebook (Willett, 2012). Meanwhile, Lazar et al. (2020) used the concept of "digital learning tool" to refer to digital sources used in blended learning.

Blended learning is used to describe learning that mixes various event-based activities: self-paced learning, live e-learning and face-to-face classrooms. Self-paced learning is what the learner does by executing the e-learning process. Self-paced activities can be taken at the learner's leisure irrespective of time and place. The important thing these days is not only to access knowledge but timely access of relevant and interesting knowledge. The value of self-paced learning is not only that it can reach everyone at any time and anywhere, but that it can teach the learner appropriately, providing the right skills at the right time. Live e-learning takes place in a virtual classroom at a scheduled time at which the learner undertakes to attend. Thus, enable learners to collaborate with one another, share ideas, and ask questions in real time.

The blended learning environment is also favorable for organizing active teaching approaches such as STEM education (ElSary, 2021; Vasileva-Stojanovska, 2015; Fatade, 2012), problem-based teaching, project teaching (Yunus et al., 2021) and collaborative teaching (Kandakatla et al., 2020). In addition, many specialized models with characteristics suitable for blended learning in mathematics education have been studied. Blended learning is a teaching approach that positively impacts students' learning and teachers' instruction. Through individual interaction with students, teachers can see the learning needs of students, thereby allowing them to adjust or design lesson plans to suit students' learning progress.

6.1. Levels of Blended Learning

A. Activity Level: At the activity level of BL takes place when a learning activity contains both face-to-face and online or computer mediated elements.

B. Course Level: At the course level it engages face-to-face and online activities that are used as part of a course

C. Program Level: At the program level of BL, there are certain face-to-face courses that are

required for a program and the rest can be taken at a distance or online

D. Institutional Level: At the Institutional level Blended learning enables students to have face-to-face classes at the beginning and at the end of the courses with online activities in between

6.1.1. Flipped Classroom Approach

One way to use technology in a blended learning model is the *flipped classroom* approach. The flipped classroom takes the lecture part of the instruction and places it in videos or podcasts for students to watch at night as their homework (Ma and Wang, 2019). Class time is then used for extra guidance and work time on the assignments. There are many advantages to this model of learning; however, Huang, C. Y., & Liaw (2018) noted that “showing video lectures alone is not flipping your classroom - you must add active learning experiences” (p. 8). One such advantage to the flipped classroom is time. Watching the videos at night frees up valuable classroom time for teachers to offer extra guidance to those students who are struggling and provide more challenging activities for

those who find it easy, as well as providing great opportunities for one-on-one mentoring or collaborating (Chen et al, 2018).

7. Methodology

The research designs adopted for this study were control and quasi-experimental group design. Students were divided into control and experimental groups. The experimental group was with a blended learning environment while the control group was a traditional learning environment. The population for the study comprised all public Senior Secondary School two students in Ogun State, South West Nigeria. The purposive sampling technique was adopted with the total of three hundred and twenty (320) Senior Secondary Two Mathematics students were involved. Quadratic and Simultaneous Equations Achievement Test (QSEAT) was used as an instrument, the reliability coefficient value for the essay QSEAT was 0.82. The data collected was analysed using an inferential statistical test of analysis of covariance (ANCOVA). An alpha level of 0.05 was used for all statistical tests.

8. Results and Discussion

Table 1. Mean and Standard Deviation of Pre-test and Post-Test Achievement score in Experimental and Control Group

Group	Experimental		Control	
	Pre-Test Scores	Post-Test Scores	Pre-Test Scores	Post-Test Score
Mean	13.73	22.57	10.08	20.60
Std. Deviation	3.48	2.94	3.51	3.92
N	160		160	

Table 1 shows that the experimental group has a mean pre-test achievement score of 13.73 and a mean of post-test achievement score of 22.57 while the control group has a mean pre-test achievement score of 10.08 with a mean of post-test achievement score of 20.60. This indicates that the experimental group who used Blended Learning (BL) to teach recorded higher achievement scores than the control group that was exposed to Traditional Learning (TL) method.

Hypothesis One (H0): There is no significant effect of Blended Learning Model (BLM) and Students' achievement in QSEAT at Senior Secondary School

Hypothesis One (H1): There is significant effect of Blended Learning Model (BLM) and Students' achievement in Quadratic and Simultaneous Equations at Senior Secondary School

Table 2. ANCOVA Results of Blended Learning Model and Students' Achievement in QSEAT at Senior Secondary School

Source	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	425.067 ^a	22	19.321	1.479	0.143
Intercept	16419.935	1	16419.935	1256.974	0.000
Blended Learning	354.798	12	29.567	2.263	0.028
QSEAT	6.403	1	6.403	0.490	0.488
Error	483.333	37	13.063		
Total	26370.000	160			
Corrected Total	908.400	159			

a. R Squared = .468 (Adjusted R Squared = .152)

The table 2 presented above is the ANCOVA of students' achievement scores that revealed the effect of Blended Learning on students Achievement in Quadratic and Simultaneous Equations at 0.05 significance level. The F-stat. value of 2.26 for treatment is significant at 0.03 which is less than 0.05 alpha levels and thus the null hypothesis is rejected and accepts the alternative hypothesis. We therefore conclude that there is a significant effect of Blended Learning on students' achievement in Quadratic and Simultaneous Equations.

This indicates that there is a significant difference in the mean achievement scores of students who were taught with Blended Learning as instructional guide and those who were exposed to traditional method of teaching.

Hypothesis Two (H₀): There is no significant impact of Blended Learning and Students' motivation towards learning and teaching of QSEAT at Senior Secondary School.

Hypothesis Two (H₁): There is significant impact of Blended Learning and Students' motivation towards learning and teaching of Quadratic and Simultaneous Equations at Senior Secondary School

Table 3. ANCOVA Results of Blended Learning Model and Students' Achievement in QSEAT at Senior Secondary School

Source	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected Model	94.028 ^a	13	7.233	0.526	0.896
Intercept	88.415	1	88.415	6.430	0.015
Post Control	3.603	1	3.603	7.262	0.0611
Post Experimental	92.900	12	7.742	8.563	0.060
Error	632.556	46	13.751		
Total	6827.000	160			
Corrected Total	726.583	159			
a. R Squared = .129 (Adjusted R Squared = -.117)					

The BL Experimental Group and Control group have been compared by means Analysis of Covariance (ANCOVA) test, and the data acquired are demonstrated in the table above. The finding shows that there was a statistically significant difference between Experimental and Control Group and the impact of students' achievement in Quadratic and Simultaneous Equations.

The effect of a blended learning environment on the students' academic performance has been analyzed. It was discovered that the academic success of the students who have studied in a blended learning environment in which online learning environment and face to face learning environment are used together increases. The fact that the students can get access to information in any place without being limited by boundaries or spaces with a blended learning environment, and the fact that a blended learning environment provides exchange of information and ideas in the cyber world are the factors causing the increase of their achievement.

The result of this study asserted that a blended learning environment increases students' academic achievement and it was supported by Dikli, S., & Kocoglu (2018); Leung (2020); and Keramati et al (2019) in the studies conducted on blended learning. They are the courses in which the online courses are used in the best way. Not only does blended learning provide an environment in which there is simultaneous feedback and effective usage of technology but also it provides the learners in an online learning environment to be in interaction.

The results obtained from the statistical analysis indicated a significant difference in achievement scores between the experimental and control groups, favoring the blended learning approach. The findings suggest that the integration of technology and online resources enhanced students' understanding of quadratic and simultaneous equations, as well as their problem-solving skills. Importantly, this study highlights the potential of blended learning to promote active student engagement and improve academic outcomes in mathematics education.

9. Conclusions

This study has shown the positive impact of the BL in encouraging students' achievement in Quadratic and Simultaneous equations (QSEAT). The test results indicated that students who received instruction through blended learning strategies outperformed those who received traditional lecture-based instruction. It is therefore recommended that this

approach be put to use in the teaching and learning of Quadratic and Simultaneous Equations. Not only blended learning affords an environment in which there is simultaneous feedback and effective usage of technology but also it provides the learners in an online learning environment to be in interaction. This benefit of blended learning is proof that it will gain an

effective and significant place in the modern education system.

Blended learning provided an interactive and dynamic learning environment that engaged students in a variety of instructional methods, including computer-based learning activities. This approach facilitated independent thinking, problem-solving skills, and critical analysis, all of which are essential for success in Quadratic and Simultaneous Equations. The integration of technology also allowed students to receive immediate feedback and access to additional learning resources, further enhancing their understanding of the subject matter. The findings of this study suggest that the incorporation of blended learning into Mathematics education can yield significant improvements in students' achievement. This pedagogical approach not only enhances students' understanding of Quadratic and Simultaneous Equations but also promotes their overall mathematical reasoning and problem-solving abilities.

Furthermore, the study underscores the importance of considering alternative instructional strategies, such as blended learning, to cater to the diverse learning needs and preferences of students. By embracing the benefits of technology in education, educators can create a more inclusive and effective learning environment that fosters students' success in Mathematics. Based on these findings, it is recommended that educational institutions and policymakers give due attention to the integration of blended learning approaches into the curriculum for Quadratic and Simultaneous Equations. Additionally, further research should be conducted to explore the long-term effects of blended learning on students' mathematical achievement and to identify best practices for its implementation. In conclusion, the positive impact of blended learning on students' achievement in Quadratic and Simultaneous Equations highlights its potential to revolutionize Mathematics education and empower students to excel in this important subject area.

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